Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 2, 2017					

ENG338 – Machine Design Principles	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES
The exam has 5 questions and you must answer any **four of the five** questions. The exam is for 100 marks. Each question carries 25 marks Suggested time for each question is 45 minutes.
EXAM CONDITIONS
<u>You may begin writing from the commencement of the examination session.</u> The reading time indicated above is provided as a guide only.
This is a RESTRICTED OPEN BOOK examination
Any non-programmable calculator is permitted
No handwritten notes are permitted
No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
Lecture Textbook/s (Unannotated)	1 x 20 Page Book

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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1. Fig.1 shows a band brake used with a punch press. When in use, the motor and flywheel of the punch press run continuously. A compressed-air-actuated, multiple-disk clutch connects the flywheel to the countershaft each time the press is to punch or form metal. In use, the clutch is released when the crank is 130°past bottom dead centre. The brake is to be engaged at this point, and bring the crank to rest at top dead centre. The crank assembly has a mass moment of inertia of approximately 15 N.m.s^2 and is rotating at the rate of 40 rpm when the brake is engaged. The brake will be used about three times per minute, so the maximum pressure on the band lining should be limited to about 0.20 MPa for long life. Coefficient of friction can be taken as 0.30.

i. Determine the required band width.
ii. Determine the required force F.
iii. Would any combination of direction of rotation and value of coefficient of friction make the brake self-locking? Explain, briefly.

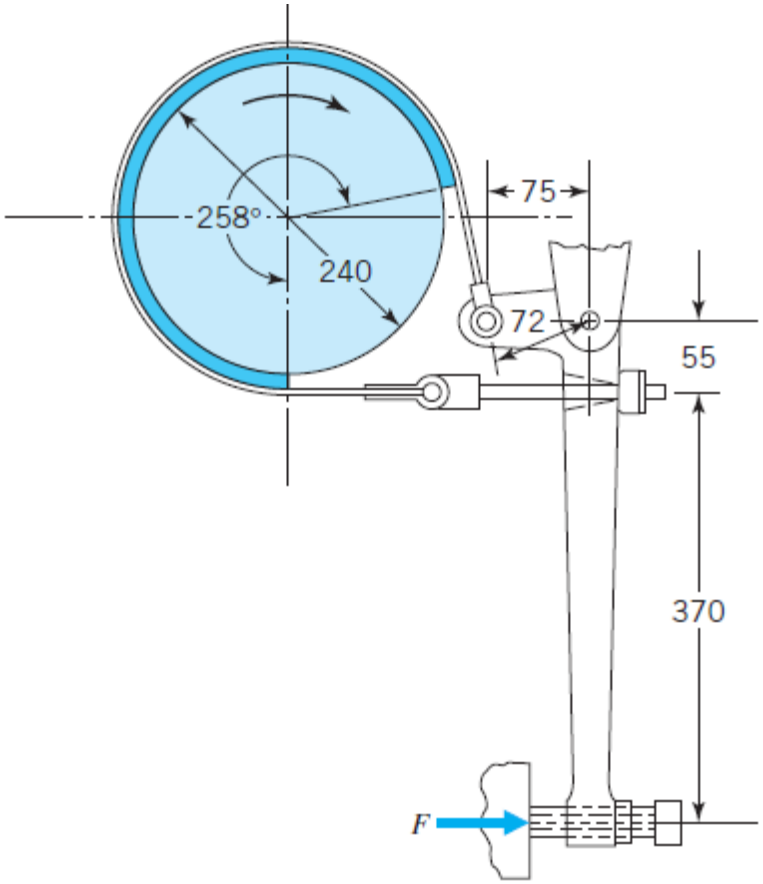

Fig.1 Band brake with a punch press (ref: Fundamentals of Machine Component Design, 5th Edition, Wiley.)

2. A bevel pinion and shaft are shown in Fig.2. Bearing A takes thrust. The left end of the shaft is coupled to an electric motor, and the right end is free. Load components applied by the mating bevel gear are shown.

(a) Draw load, shear force, and bending moment diagrams for the shaft in both horizontal and vertical planes, plus torsional-load and axial-load diagrams.
(b) Determine the radial and thrust loads applied to the two bearings.
(c) Identify the critically loaded shaft cross section and estimate the safety factor with respect to eventual fatigue failure using the following data:

- shaft diameter = 33 mm,
- K_f = 1.3, 1.2, and 1.3 for bending, torsional, and axial loading, respectively;
- Material is steel with S_u = 900 MPa and S_y = 700 MPa; and critical surfaces have a ground finish.

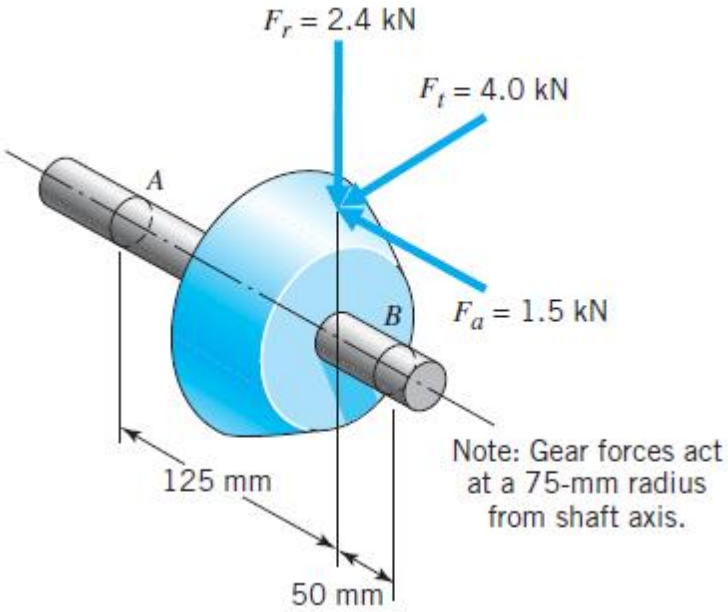

Fig.2 Bevel pinion and shaft (ref: Fundamentals of Machine Component Design, 5th Edition, Wiley.)

3. The four helical gears shown in Fig. 3 have a module in the normal plane of 4 mm and a pressure angle in the normal plane of 0.35 rad. The motor shaft rotates 550 rpm and transmits 20 kW. Other data are on the drawing.

(a) What is the speed ratio between the motor (input) and output shafts?
(b) Determine all force components that the 20-tooth pinion applies to the 50-tooth gear. Make a sketch showing these forces applied to the gear.
(c) The same as part (b), except for the force components that the 50-tooth gear exerts on the 25-tooth pinion.

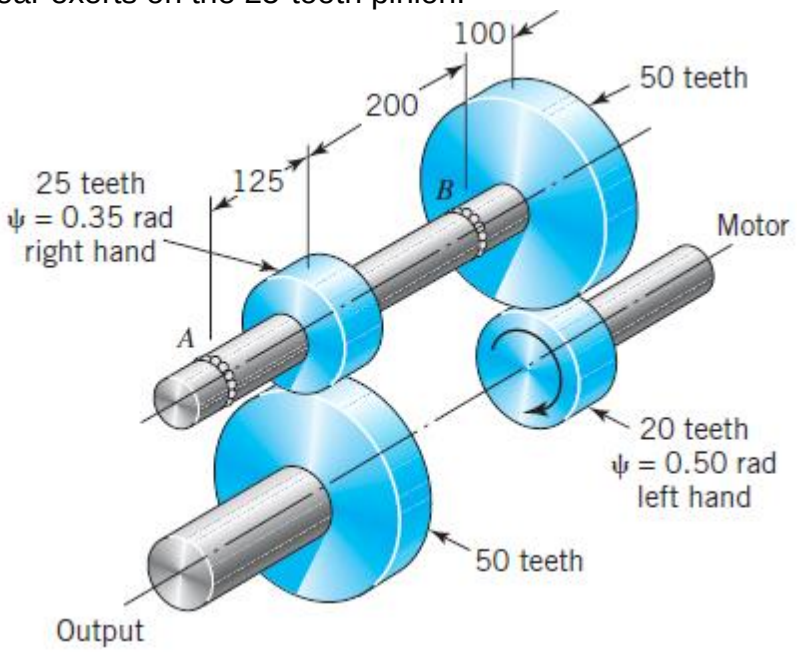

Fig.3 Helical gear assembly (ref: Fundamentals of Machine Component Design, 5th Edition, Wiley.)

4. Design a pair of spur gears to connect to a 75kW, 3200rpm motor to a 800rpm load shaft. Shock loading can be neglected. The centre-to-centre distance should be as small as possible. You must also ensure that there is good contact ratio. A life of 4 years of 2,500 hours/year of operation is desired. The likelihood of failure should not exceed 10 percent. The design should involve use of standard gear system. Justify all assumptions you make. A schematic is shown in Fig.4

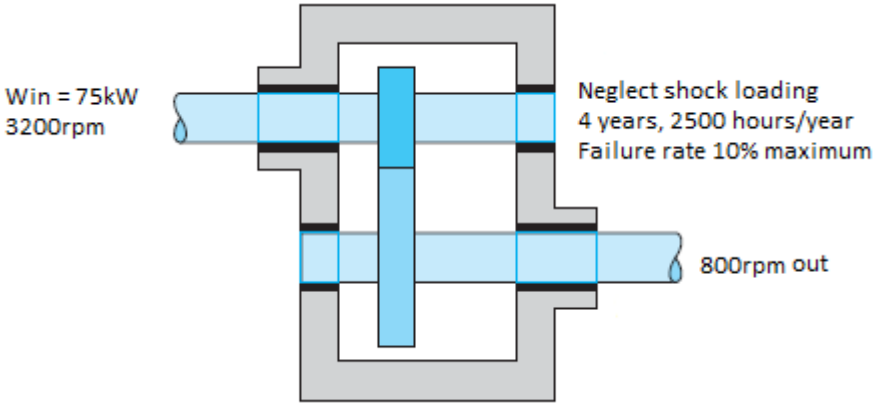

Fig.4 Schematic for Question.4

5. A 19kW, 1750-rpm electric motor drives a machine through a multiple V-belt. The size 5 V-belts used have an angle, β, of 18° and a unit weight of 0.21 kg/m. The pulley on the motor shaft has a 94mm. pitch diameter (a standard size), and the geometry is such that the angle of wrap is 165°. It is conservatively assumed that the maximum belt tension should be limited to 667N, and that the coefficient of friction will be at least 0.20. How many belts are required?